OFDMA DOWNLINK & SC-FDMA UPLINK INTEGRATION WITH ADAPTIVE MODULATION FOR BROADBAND WIRELESS COMMUNICATION

Ph.D. Synopsis of thesis *submitted in partial fulfilment of the requirements for the degree of*

Doctor of Philosophy
in
Electronics & Communication Engineering

Submitted By

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Under the supervision of

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1. Introduction

With each generation of wireless mobile systems, higher data rates are aimed in order to provide advanced multimedia services with present access. Thus, modern broadband mobile technologies must struggle with problems deriving from high-data rate transmissions over wireless channels that are narrow in bandwidth and power. Till now, the most popular multi-carrier communication technique used to overcome these limitations is the orthogonal frequency-division multiplexing (OFDM) due to its robustness against frequency selective fading channels. However, it suffers from problem of high peak-to-average power ratio (PAPR) which may be particularly difficult in uplink transmissions as costly high-power linear amplifiers are needed in user terminals. These features are rooted by orthogonal frequency-division multiple access (OFDMA), the multiple access technique based on OFDM, single carrier frequency-division multiple access (SC-FDMA) has become an alternative to these techniques since, due to its low PAPR, it was selected as the uplink multiple access scheme in 3rd generation partnership project long term evolution. This technique is placed on the use of single-carrier modulation with frequency-domain equalization (SC-FDE) and it can be characterized as a version of OFDMA in which pre-coding and inverse pre-coding stages are added at the transmitter and receiver ends respectively. The reduction of PAPR in the uplink transmission results in a mitigation on the constraints regarding power efficiency in user terminals and, hence, in lower manufacturing costs. This thesis is designed to provide a mathematical analysis of the performance for a SC-FDMA system over fading channels in terms of bit error rate (BER), PAPR reduction and spectral efficiency. The obtained results will be, first, validated through simulations and, then, compared to those obtained with OFDMA. These resemblances will allow us to determine the difference in performance between OFDM and SC-FDMA.

The OFDM has many advantages such as high bandwidth efficiency, robustness to the selective fading problem, use of small guard interval, and its ability to combat the ISI problem. So, simple channel equalization is needed instead of complex adaptive channel equalization. Apart from various advantages of OFDM, there are certain disadvantages also. The frequency offset of the sub-carriers and the high PAPR are the major limitations of OFDM.

2. Objectives, Contributions and Scope of the Present work

- The objective of the research work is to reduce the peak to average power ratio (PAPR) & improve the bit error rate (BER) in OFDMA, SC-FDMA & MIMO systems using different techniques.

- *Analysis of ICI self cancellation (SC) & adaptive modulation in OFDMA:* In the thesis work, analysis of the self cancellation scheme is done and BER is improved as compared to simple OFDM. Implementation of adaptive modulation is used to remove non linearity in OFDMA.

- *Proposed method of wavelet transform based OFDMA system:* In this thesis work, the proposed method of wavelet transform based OFDMA system using BPSK modulation which is used to improve the BER in OFDMA, is given and this method replaces fast fourier transform method which has more BER.

- *Proposed kalman filter scheme & extended kalman filter with companding scheme in OFDMA system:* The proposed kalman filter scheme & extended kalman filter with companding scheme has been used to reduce PAPR and to improve the BER in OFDM system.

- *Analysis of the SC-FDMA system using subcarrier mapping & roll-off factor:* second objective of this thesis is to analyze the PAPR using different subcarrier mapping scheme in SC-FDMA and also to analyze the effect of roll-off factor in SC-FDMA system.

- *Proposed super frame with kalman filter based companding scheme in SC-FDMA System:* In this thesis we apply the proposed super frame with kalman filter based companding scheme to reduce the PAPR in comparison to conventional SC-FDMA system.

- *Implementation of MIMO OFDMA & MIMO SC-FDMA system:* The above said all proposed techniques have been implemented in MIMO system to check and compare the results with the SISO system.

- *Scope of the work:* The scope of the work for high data rate transfer without error used for forthcoming generation. Secondly the battery power consumption of mobile terminal is less to reduce the PAPR of OFDM and SC-FDMA system.

3. Simulation & Implementation of Proposed Work

❖ Wavelet Transform based OFDM system to Improve BER with Kalman Filter (Proposed Scheme)

In our proposed system using kalman filter in order to improve BER by minimizing the effect of ICI and noise. Obtained results from proposed system simulation showed acceptable BER performance at low SNR. Wavelets are known to have compact hold (localization) both in time and frequency domain, and acquire better orthogonality. Since DWT based OFDM does not use cyclic prefix, so a better spectral containment of channels can be achieved. Discrete wavelet transform employs low pass filter (LPF) and high pass filter (HPF) which operate as quadrature mirror filters fulfilling perfect reconstruction and orthogonal properties.

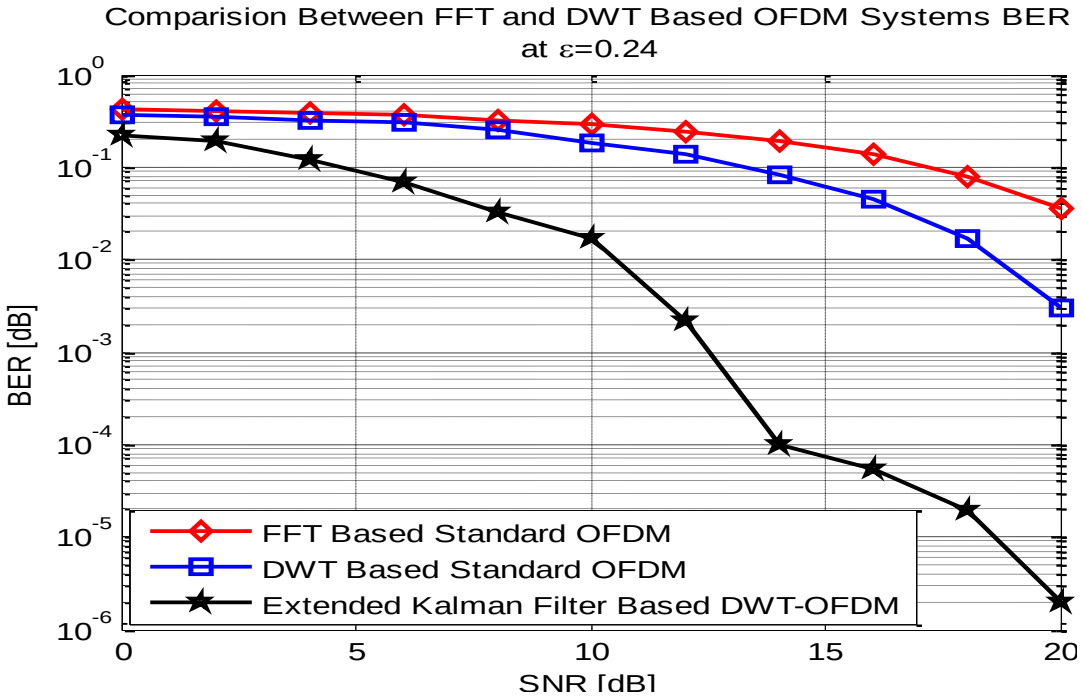
Comparision Between FFT and DWT Based OFDM Systems BER
at ε=0.24
BER [dB]
SNR [dB]
FFT Based Standard OFDM
DWT Based Standard OFDM
Extended Kalman Filter Based DWT-OFDM

Figure 1.1 BER plot for QAM SISO FFT/DWT OFDM systems

❖ Proposed Companding with Kalman Filter Scheme based OFDM system to reduce PAPR

This is the proposed scheme to reduce PAPR in OFDM systems. Companding using kalman filter is an algorithm to reduce the dynamic range of a signal by increasing the amplitudes of the smaller signals. The average signal power is increased with this technique. PAPR is reduced to an extent if dynamic range is reduced

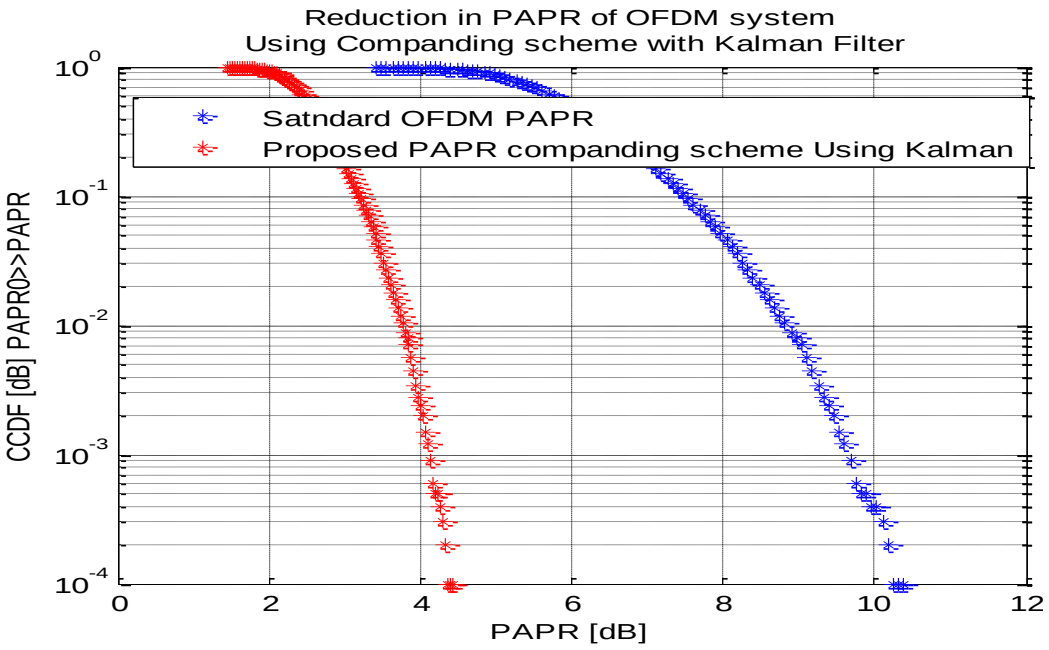
Reduction in PAPR of OFDM system
Using Companding scheme with Kalman Filter
Satndard OFDM PAPR
Proposed PAPR companding scheme Using Kalman
CCDF [dB] PAPR0>>PAPR
PAPR [dB]

Figure 1.2 Comparison of CCDF plots of conventional OFDM and companding with kalman filter scheme based OFDM system

- **Proposed DWT based SC-FDMA with Extended Kalman Filter to reduce PAPR using super frame technique**

  The companding with kalman filter based scheme for maintaining good PAPR reduction performance using discrete wavelet transform based systems have been proposed. Simulation results shows that the proposed scheme provides good results in comparison to other existing schemes. A new scheme called IFDMA with super frame (SF-IFDMA), most suitable for the IFDMA systems with small number of subcarriers N, for example $N \leq 512$ has also been proposed.

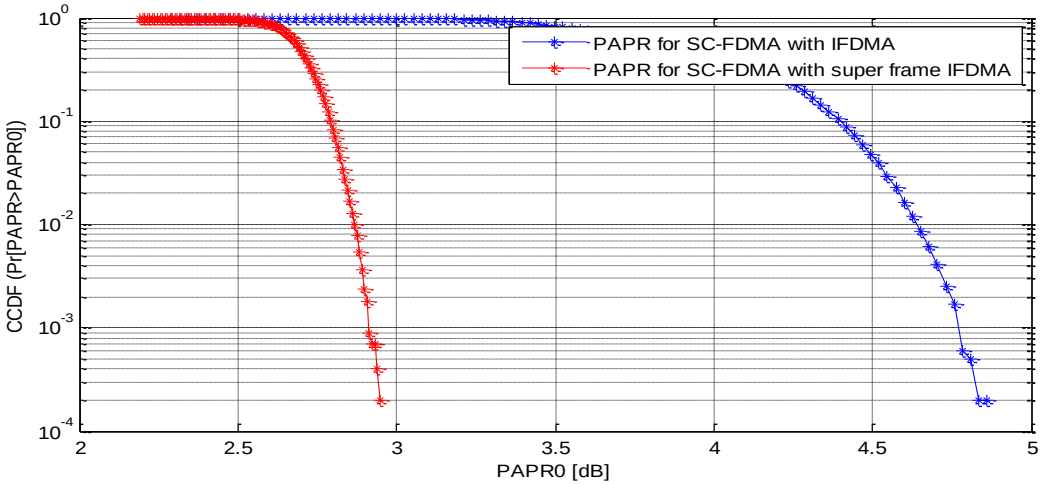

Figure 1.3 Super frame scheme with IFDMA with roll off factor=0.42 QPSK Modulation

❖ **Proposed DWT based MIMO OFDM System to improve BER and Proposed Superframe with Companding & Kalman Filter based MIMO SC-FDMA System to reduce PAPR**

The results observed that the proposed BER performance of MIMO OFDM system for 4*4 DWT MIMO OFDM gives better results than conventional 4*4 MIMO FFT OFDM systems. This system is suitable for future wireless communication system.

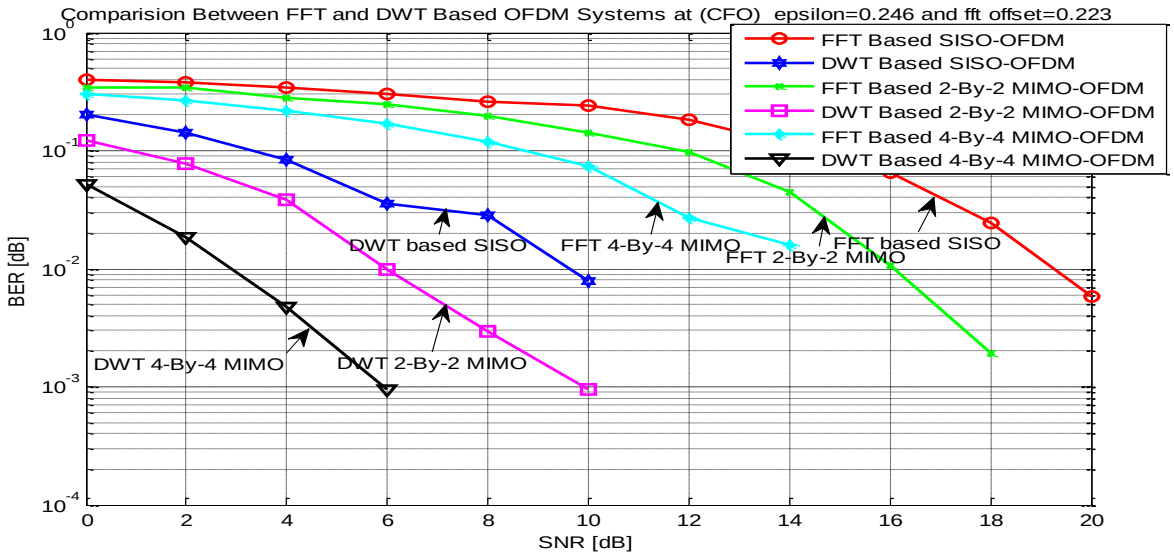

Figure 1.4 Comparison b/w FFT based and DWT based MIMO-OFDMA systems at CFO ε =0.246 (DWT) and ε =0.223 (FFT)

Multiple input multiple outputs (MIMO) spatial multiplexing technique offers a smart way to significantly increase the peak data rate. Between the various MIMO techniques, transmit eigen-beam-forming (TxBF) is a promising technique with several benefits. The use of precoding such as TxBF may increase the PAPR because each transmit signal becomes a composite signal due to spatial processing.

Disadvantages of OFDMA compared to SC-FDMA are its strong sensitivity to carrier frequency changed and strong sensitivity to nonlinear distortion in the power amplifier due to the high PAPR, for both properties of the multicarrier nature of OFDMA. PAPR was a main factor in selecting SC-FDMA over OFDMA as the uplink air interface for 3GPP LTE.

PAPR characteristics of different types of MIMO-SCFDMA systems with Companding cum Kalman filter at roll off factor 0.42. The results shown in figure 1.5 achieve the PAPR 2.6 dB at roll of factor 0.42 using super frame based IFDMA with companding & kalman filter based system provides best results among other types of MIMO-SCFDMA systems.

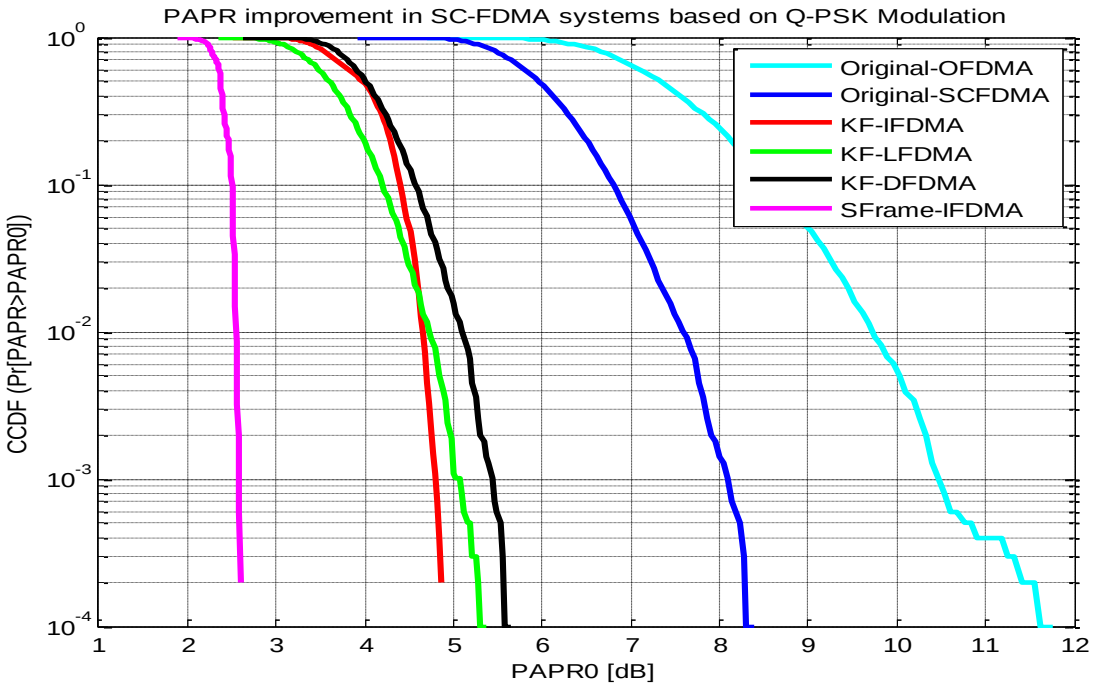

Figure 1.5 PAPR Reduction in 2 by 2 MIMO SCFDMA using Super frame with Companding & Kalman Filter with roll of factor 0.42

4. Results & Discussion

The work done in this thesis to achieve above mentioned objectives are summarized below.

- **BER improvement in OFDMA system:** Wavelet transform based OFDM provides a very interesting and powerful alternative to FFT OFDM, the strength of the wavelets being the better time/frequency localization and distribution in this domain. The BER performance in DWT based system, improvement that can be obtained is about 0.1376 BER at 12 dB SNR which is suitable for OFDM system. A maximum improvement of BER using DWT with kalman filter obtained is about 0.0012 BER at 12 dB SNR which is suitable for next generation OFDM system which has been shown in Table 1.1. The conventional OFDM based on FFT with self-cancellation scheme, OFDM based on FFT with adaptive modulation scheme, conventional DWT based OFDM and DWT based OFDM with kalman filter under different values of carrier frequency offset (CFO) together with their comparison for best achievable BER have been presented. After comparison it has been found that DWT based OFDM with kalman filter system is a feasible way to reach the next generation of wireless communication for large data rates and applications.

Table 1.1 Simulation results of BER performance DWT based OFDM using Extended kalman filter with freq offset= 0.24 through Matlab Tool

S.No.	SNR	BER for FFT OFDM	BER for DWT OFDM	BER for DWT OFDM with Kalman Filter
1	10	0.2849	0.1806	0.0168
2	12	0.2442	0.1376	0.0021

- **PAPR reduction techniques in OFDMA system:** The performance in terms of PAPR in OFDMA by using some pre-coding techniques such as partial transmit sequence (PTS), zadoff-chu transform (ZCT) matrix, kalman filter based along with μ-law companding has been analyzed. These pre-coding techniques produced the lower PAPR as compared to conventional OFDM system. Furthermore companding algorithm with kalman filter is better than ZCT precoding and PTS scheme because it has produce the lowest PAPR than ZCT precoding and PTS scheme. The performance of companding algorithm with kalman filter that introduced the better PAPR reduction of 4.3dB can be achieved for suitable low power consumption communication system which has been shown Table 1.2..

Table 1.2 Performance of PAPR in OFDM system

Peak to Average Power Ratio	Conventional OFDM	Proposed Kalman filter based OFDM	Proposed Companding Algorithm with kalman filter based
PAPR	12 dB	7.7 dB	4.3 dB

The obtained results show that the proposed methods have got better results than conventional OFDM

- **Peak power reduction methods in SC-FDMA system:** PAPR reduction schemes for carrier-aggregated systems using SC-FDMA for uplink transmission have been presented. As the PAPR problem is a practical issue, complexity and control signalling overhead requirements of the PAPR reduction schemes are also of importance. The companding algorithm with kalman filter scheme using discrete wavelet transform based SC-FDMA system for maintaining good PAPR reduction

performance have been proposed. Also a new scheme called IFDMA with super frame (SF-IFDMA), most suitable for the IFDMA subcarrier mapping systems with small number of subcarriers N e.g. $N \leq 512$ have been proposed. The later scheme is very effective in reducing the PAPR in IFDMA systems, especially when N is small. It can achieve a significant reduction of PAPR of 4.9 dB at roll off factor 0.22. On increasing the roll off factor to 0.82, PAPR has been reduced to 2.1dB which has been shown Table 1.3. This reduction comes at the price of system complexity as well as delay introduced from waiting the reception of "B" IFDMA frames at the receiver before starting in the demodulation process.

Table 1.3 Performance of PAPR in SC-FDMA system at different roll of factor

Peak to Average Power Ratio	Conventional SC-FDMA IFDMA subcarrier mapping at roll off factor 0.22, 042, 0.82	Proposed SC-FDMA IFDMA with super frame scheme at roll off factor 0.22, 0.42, 0.82
PAPR	6.5 dB, 4.7dB, 2.8dB	4.9dB, 3.0dB, 2.1dB

- **Performance & Implementation of MIMO-OFDMA & MIMO-SCFDMA:** BER performance of SISO FFT OFDM is calculated as to be 0.1822 at 12dB SNR. SISO DWT OFDM provides a BER of 0.0 at 12dB SNR. The BER performance of 2by2 MIMO FFT OFDM is 0.1415 at 10dB SNR which has been shown Table 1.4. The DWT OFDM provides a BER of 0.0010 at 10dB low SNR value which is suitable for next generation system. MIMO SC-FDMA can achieve significant reduction of PAPR of 4.0dB at roll off factor of 0.22 and on increasing the roll of factor to 0.82, the PAPR is reduced to1.8dB which has been shown Table 1.5. The systems are implemented in FPGA and results are comparable with the simulation results. Finally, it has been shown that a better understanding of the system design implications of fundamental performance tradeoffs (such as rate versus BER versus SNR) is required to enhance performance. The high bandwidth efficiency obtained shows that MIMO-OFDM is a potential technology for future broadband wireless access.

Table 1.4 Performance of BER in MIMO OFDM system

S.No.	SNR	BER for SISO FFT OFDM	BER for SISO DWT OFDM	BER for 2x2 MIMO FFT OFDM	BER for 2x2 MIMO DWT OFDM	BER for 4x4 MIMO FFT OFDM	BER for 4x4 MIMO DWT OFDM
1	10	0.2437	0.0078	0.1415	0.0010	0.0744	0
2	12	0.1822	0	0.0978	0	0.0273	0

Table 1.5 Performance of PAPR in MIMO SC-FDMA system

Peak to Average Power Ratio	Conventional MIMO SC-FDMA IFDMA at roll off factor 0.22, 042, 0.82	Proposed Superframe with Companding algorithm & Kalman filter based MIMO at roll off factor 0.22, 0.42, 0.82
PAPR	6.5dB, 4.7dB, 2.8dB	4.0dB, 2.6dB, 1.8dB

4.1 Performance Analysis & Comparison of overall work done

The performance analysis and comparison of overall work done has been achieved to reduce the PAPR and improve the BER using MATLAB and Simulink which is suitable for broadband wireless communication system. Table 1.6 shows the comparison of different techniques for analysis of BER and PAPR. Proposed DWT based OFDM system using kalman filter shows BER 0.0021 at SNR 12dB. Second the PAPR is achieved 4.3dB using proposed scheme companding algorithm with kalman filter in OFDM system. The above achievements show the less power consumption of mobile terminal and more data transfer without error which is more suitable for next generation broadband wireless communication OFDM downlink system.

Table 1.6 Performance analysis of BER & PAPR in OFDM for downlink transmission using different proposed scheme

Techniques used for improvement of BER	BER analysis	Techniques used for reduction of PAPR	PAPR Analysis
Conventional FFT based OFDM system at SNR 12 dB	0.2442	Conventional Partial transmission scheme in OFDM system	8.3dB
Proposed DWT based OFDM system at SNR 12 dB	0.1376	Proposed scheme with kalman filter in OFDM system	7.7dB
Proposed DWT based OFDM system using kalman filter at SNR 12	0.0021	Proposed scheme companding with kalman filter in OFDM system	4.3dB

To reduce the PAPR using SC-FDMA uplink transmission depending on roll of factor has been shown in Table 1.7. The PAPR has been achieved 1.0dB when the roll off factor is 0.82. This shows that using SC-FDMA uplink transmission, a much reduction in PAPR has been achieved as compared to conventional SC-FDMA system.

Table 1.7 Performance analysis of PAPR in SC-FDMA for uplink transmission using different proposed scheme

Sr. No.	Reduction techniques for PAPR	Roll of factor (α)	PAPR Analysis
1.	Standard SC-FDMA with IFDMA subcarrier mapping	0.82	2.8dB
2.	Proposed SC-FDMA with IFDMA subcarrier mapping using super frame scheme	0.82	2.1dB
3.	Proposed super frame + companding algorithm & kalman filter in SC-FDMA IFDMA mapping	0.82	1.8 dB

This achievement of PAPR is suitable for next generation uplink transmission SC-FDMA system. This is consumption less power for mobile terminal as to increase long battery time period.

5. Contribution by the Candidate

Publications in journal/conference directly related with the Ph. D thesis:

1. **Sajjan Singh**, S. V. A. V. Prasad, Pardeep "Reduction of PAPR by intelligently applying Companding Scheme with Kalman Filter in OFDM systems" *IUP Journal of Telecommunication,* Vol. 6, No. 2, May, 2014.
2. **Sajjan Singh**, Pardeep, Dr. S. V. A. V. Prasad "SC-FDMA based systems to Reduce PAPR by using a Modified Companding Scheme" *International Journal of Computer Application (IJCA),doi>10.5120/15318-3620,* ***Impact factor: 0.821,*** Vol. 88, No. 1, pp. 32-39, Feb. 2014.
3. **Sajjan Singh**, Pardeep, Dr. S. V. A. V. Prasad "Improvement of BER in Wavelet Transform based OFDM system with kalman Filter" *Journal of Communication Engineering & Systems (JoCES),* Vol. 4, No. 1, pp. 1-8, 2014.
4. **Sajjan Singh**, Dr. S. V. A. V. Prasad "Design and analysis of BER for FFT OFDM and DWT OFDM System using Haar Wavelet Transform" *IUP Journal of Telecommunications,* Vol. 3, pp. 7-15, Aug. 2013.
5. **Sajjan Singh**, Pardeep, Dr. S. V. A. V. Prasad "A Kalman Filter Approach to Reduce PAPR in OFDM Transmission" *International Journal of Computer Application (IJCA),* ***Impact factor: 0.821***, pp. 8-13, Dec. 2013.
6. **Sajjan Singh**, Manoj Kumar, Dr. S. V. A. V. Prasad "Super Frame Technique to Reduce Peak to Average Power Ratio in Single Carrier OFDMA System" ***International Journal of Computational Intelligence Techniques, Impact factor value: 4.47,*** **Doi>10.9735/0976-0466.3.2** ISSN: 0976–0466 & E-ISSN:0976–0474, Vol. 3, No. 2, pp. 76-78, 10 Nov. 2012.
7. **Sajjan Singh**, Manoj Kumar, Dr. S. V. A. V. Prasad "Analysis of roll-off-factor to reduce the PAPR in SC-FDMA using Companding Scheme" ***International Journal of Computational Intelligence Techniques, Impact factor value: 4.47,*** **Doi>10.9735/0976-0466.3.2** ISSN: 0976–0466 & E-ISSN: 0976–0474, Vol. 3, No. 2, pp. 76-78, 10 Nov. 2012.
8. **Sajjan Singh**, Shelej khera, Shailender "PAPR Reduction Using Zadoff-Chu Matrix Transform Based Pre-Coding Technique and Partial Transmit Sequence in OFDM System" *International Journal of Engineering Research & Technology (IJERT),* ISSN: 2278-0181, Vol. 1, No. 6, pp. 1-5, Aug. 2012.

9. **Sajjan Singh**, S. V. A. V. Prasad, Sangeeta jajoria "Analysis of BER Performance of OFDM System by Adaptive Modulation" *International Journal of Recent Technology and Engineering*, ISSN: 2277-3878, Vol. 1, No. 4, pp. 6-9, 05 Oct. 2012.
10. **Sajjan Singh**, Dr. S. V. A. V. Prasad "Design SC-FDMA based system for uplink broadband communication to comparing of OFDMA system" Presented at *2nd National Conference on Machine Intelligence and Research Advancement* in BPS Mahila University, Khanpur, Sonepat, March 19th -20th , 2015
11. **Sajjan Singh**, Abhishek Gupta, Manoj Kumar "Enhancement of MIMO-OFDMA Performance" *In National Conference on Emerging trends in Electronics & communication in BRCM CET, Bahal*, 25-26 Oct. 2013.
12. **Sajjan Singh**, Manoj Kumar, Dr. S. V. A. V. Prasad "Super Frame Technique to Reduce Peak to Average Power Ratio in Single Carrier OFDMA System" *In 3rd International Conference on Next Generation Communication and Computing Systems (ICNGC2S-12), Ghaziabad, India*, 22-23 Sept. 2012.
13. **Sajjan Singh**, Manoj Kumar, Dr. S. V. A. V. Prasad "Analysis of roll-off-factor to reduce the PAPR in SC-FDMA using companding scheme" presented at 3rd *International Conference on Next Generation Communication and Computing Systems (ICNGC2S-12),* September 22-33, 2012, Ghaziabad, India.

Publication indirectly related with the Ph. D thesis:

14. **Sajjan Singh**, Yogesh Bhardwaj, Suman Kumar "Revolution of Integrated Circuit in the ERA of 2020" *International Journal of Computer Application (IJCA),* ISSN: 0975-8887, pp. 35-39, Dec. 2013.
15. **Sajjan Singh**, Rasveen, Dr. S. V. A. V. Prasad "A Parametric Scheme to Perform an Efficient and Reliable Vertical Handover" *International Journal of Engineering and Advanced Technology,* Impact factor: 1.0, ISSN: 2249-8958 (Online), Vol. 2, No. 1, pp. 77-80, Oct. 2012.
16. **Sajjan Singh**, Dr. S. V. A. V. Prasad, Pankaj Batra "Performance Analysis of LA & LS Code in LAS CDMA System" *International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE),* ISSN: 2278 – 909X, Vol. 1, No. 3, pp. 36-39, Sept. 2012.
17. **Sajjan Singh**, Dr. S. V. A. V. Prasad, Deepa Arora "Improvement of Handoff Decision in GSM-Railway Using Fuzzy Logic" *IOSR Journal of Electronics and*

Communication Engineering (IOSRJECE), ISSN: 2278-2834, Vol. 2, No. 4, pp. 36-41, Oct. 2012.

18. **Sajjan Singh**, Paramveer Narwal, Dr. S. V. A. V. Prasad "Performance Analysis of BER Improvement for Multi Carrier CDMA System" *International Journal of Engineering and Innovative Technology (IJEIT),* ISSN: 2277-3754, Vol. 2, No. 2, pp.72-74, Aug. 2012.
19. **Sajjan Singh**, Konark Sharma, M.K. Yadav "Processing of voice signal using TMS320C6713 in digital domain" *International Journal of Electronics Engineering (IJEE),* Vol. 3, No. 1, Jun. 2011.
20. **Sajjan Singh**, Lalita "PAPR Reduction Technique in OFDM: A Review" is published in the *IJMRS's International Journal of Engineering* Vol. 03, Issue 02, June 2014.
21. **Sajjan Singh**, Mamta "Fault Detection and Correction in Using Shortest Path in Wireless Sensor Networks" is published in the *International Journal of Research (IJR),* Vol-1, Issue-7, Impact factor-3.541, Aug. 2014.
22. **Sajjan Singh**, Sakshi "Pyramidal Algorithm for Image Sharpening & Edge Detection Using DWT-UM" is published in the *International Journal of Research (IJR),* Vol-1, Issue-8, Impact factor-3.541, Sept. 2014.

Seminar/Workshop/STP/FDP Attended

1. Attended Two week ISTE workshop on "Basic electronics" at NIT, Kurukshetra conducted by IIT, Bombay from 28th June to 8th July, 2011.
2. Attended One week STTP based on "Advanced DSP with Matlab" conducted by ECE Department at NITTTR, Chandigarh from 23-5-2011 to 27-05-2011.
3. Attended Two week ISTE workshop on "Research Methodology" at BRCM CET, Bahal conducted by IIT, Bombay from 25th June to 4th July, 2012.
4. Attended Two days ISTE workshop on "Akash for Education" at BRCM CET, Bahal conducted by IIT, Bombay from 10th Nov. to 11th Nov, 2012.
5. Attended Three days Regional workshop on "Experimental Research and latest Trends in Technology using Labview" at HEC, Jagadhari in association with Electrono Solution Pvt. Ltd. Bangalore from Dec.03-05, 2012.
6. Attended Ten days ISTE workshop on "Analog Electronics" at BRCM CET, Bahal conducted by Indian Institute of Technology, Kharagpur from 4th June, 2013.
7. Attended one week short term course cum Training Program on "Design Trends with EDA Tools in VLSI, Electronics and Communication Technology" under TEQIP-II

during July 06 – 10, 2013 at NIT, Hamirpur.

8. Attended one week short term course under QIP on "Medical Signals and Image Processing" held from 15-19 July, 2013 at IIT, Roorkee.
9. Attended two day AICTE sponsored National workshop "Advanced DSP with MATLAB and its applications" held on 23-24 August, 2013 at BRCM CET, Bahal.

Funded by ISTE/AICTE sponsored workshop/ Seminar/ Conference

1. AICTE has granted financial assistance of Rs. 1 lakh for the proposal submitted by me for conducting the National workshop on "Advanced DSP with Matlab and its application" in the year 2012-2013.
2. Sponsored and funded Rs 5000 by ISTE, New Delhi worked as a Organizing Secretary (Coordinator) of National workshop on "Modelling and Simulation Using Simulink with Engineering Applications" held at BRCM CET, Bahal on 13-10-2012.
3. Sponsored and funded Rs 100000 (one lakh) by ISTE, New Delhi Submitted proposal of FDP on Advanced Embedded system & VLSI Design & its applications on Feb., 2014.

Conference /Seminar/Workshop Organized

1. Organizing Secretary of National Conference on Emerging trends in Electronics & communication in BRCM CET, Bahal, 24-25 Dec., 2010.
2. Organizing Secretary(Coordinator) of National workshop on Modelling and Simulation Using Simulink with Engineering Applications held at BRCM CET, Bahal on 13-10-2012 and sponsored by ISTE, New Delhi.
3. As a Convener of AICTE sponsored National workshop "Advanced DSP with MATLAB and its applications" held on 23-24 August, 2013 at BRCM CET, Bahal.
4. As a Co-Convener & Organizing Sectary of National Conference "Emerging Trends in Electronics & Communication" held on 25-26 October, 2013 at BRCM CET, Bahal.